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Costa Rica: A Model for Sustainable Agriculture Tucked into Paradise

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Several times on my trip to Costa Rica, I found myself speechless at the pure beauty of nature in front of me. During my twenty-one years, I had never been in a place that I felt was worthy of the title of "Paradise" up until that point. Costa Rica is considered to be one amongst twenty of the most biodiverse countries in the world, with over 500,000 species, 16 different climate zones, 4 mountain ranges, and both a pacific and Caribbean coast (Butler). The exposure to greenery, plants, and animals that I had never seen before overwhelmed my senses; it re-inspired my vigor and passion for protecting the environment and the planet. During the treks through primary and secondary forests, I had never felt so small and insignificant. The plants, birds, insects, and other animals all rely on each other for survival; I was simply a guest viewing the complexity of the interconnection of species in these various ecosystems. Although I felt insignificant, I realize that my actions have serious repercussions for either protection or destruction of these ecosystems. In Costa Rica, the government, private sector, and people have begun to evaluate the repercussion of their actions on the environment around them; they have developed policy and general attitudes emphasizing the importance of protecting the natural territory.

According to the 2018 Environmental Performance Index, Costa Rica ranks 30th out of 180 countries for ecosystem vitality and environmental health (Yale). Costa Rica is quickly becoming one of the most sustainable countries in the world, but it did not always place a high value on environmental protection and sustainability. From 1940 to 1987, Costa Rica's forest

coverage reduced from 75% to 21% (Anders). With deforestation hitting an all-time high, the government, non-governmental organizations (NGOs), and Costa Rican people began to place a greater emphasis on sustainability. By 2010, Costa Rica had returned to being 52.38% forested (Anders). The government provides incentive for landowners to plant new forests and protect existing ones. Through the Fondo Nacional de Financiamiento Forestal, the Environmental Services Payment (PSA) Programs rewards property and forest owners for land conservation, including watershed protection, carbon sequestration, landscape beauty, and overall protection of biodiversity (Environmental). Moreover, private reserves assist in building biological corridors around national parks (Martin). Due to these efforts, Costa Rica has become a world leader in conserved land mass, with 26 national parks and 13 "additional protected areas" lying in the 26% of the country constituted by protected areas (Martin). Finally, local community efforts, like the group that plants mangrove trees on the OSA peninsula, epitomize the fervor of the Costa Rican people for conserving the natural beauty of their nation.

Through these initiatives, Costa Rica aims to fulfill all of the sustainable development goals laid out by the United Nations. While many countries fail to implement sustainable policies in their agricultural sector, Costa Rica has successfully begun to make progress towards satisfying the sustainable development goals related to sustainable agriculture. Specifically, five of the sustainable development goals are associated with sustainable agriculture: no poverty, zero hunger, decent work and economic growth, life below water, and life on land ("Sustainable"). Some of Costa Rica's top exports are agricultural products like bananas, tropical fruits (especially pineapple), and coffee ("What"). It is of the utmost importance that Costa Rica attains these five goals, for many of these products are normally grown using conventional farming methods.

Not only do mainstream, conventional farming practices not fulfill the sustainable development goals related to sustainable agriculture, they explicitly violate them. On large scale farms, crops are grown in monoculture, which is growing a single type of crop intensely on a large scale ("6 Problems"). As a result of this method of farming, there is a lack of variety in plant and animal species ("6 Problems"). When a variety of plant species are present, they naturally provide nutrients to the soil ("6 Problems"). Without the natural biological controls, conventional farmers must rely heavily on chemicals, like synthetic fertilizers and pesticides, to combat weeds, insects, and pests (Industrial). When the same type of crop is planted in the same place all year round, it depletes and erodes the soil ("6 Problems"). With the soil eroded, herbicides and fertilizers more easily runoff into and pollute rivers ("6 Problems"). Furthermore, herbicides and pesticides kill wildlife, even beneficial insects and native plants, and this depletes the vibrancy and diversity of neighboring ecosystems ("6 Problems"). Aside from harming native plant and animal life, traces of chemicals left on plants intended for human consumption pose human health risks ("6 Problems").

Synthetic nitrogenous fertilizers are associated with elevated NH_3 concentration in the soil, which is linked to nitrous oxide (N_2O) and nitric oxide emissions (NO) (Ravishankara). Furthermore, a majority of monoculture-based crops, like grains, are fed to livestock in concentrated feeding operations (CAFOs), and this is associated with increased methane emissions (Industrial). While carbon dioxide emissions receive most of the attention in the conversation about climate control, N_2O and methane emission also have harsh environmental impacts. In fact, N_2O depletes the ozone with global warming potential about 265 times that CO_2 and methane with 28 times that of CO_2 (Ritchie). It is impossible to have zero impact on the environment when growing crops, for there are 7 billion mouths to feed and not all of that

food can come from small, organic farms. However, Costa Rica aims to minimize the environmental impact of large scale farming. In fact, sustainable agriculture practices put in place in Costa Rica has greatly reduced the methane and nitrous oxide emissions from 1990 to 2010 (Ritchie).

Large-Scale Farming

The pineapple industry in Costa Rica has been linked to harsh impacts on the environment, in addition to the health of workers and local populations over the past decades. Local populations have cited the pollution of soil and water from chemicals used on nearby pineapple farms as the causes for local health crises. Moreover, workers have complained of abusive labor practices (Arias). However, the Costa Rican people are fervent in their environmental activism, organizing protests and marches encouraging the government to put a stop to hazardous actions occurring in the pineapple industry. In May 2017, an environmental group protested against a land permit given to a local subsidiary of Del Monte, for the designated land was too close to various protected areas (Arias). Furthermore, the Costa Rican government has become increasingly responsive to the grievances put forth by environmental activists. In 2017, the Environmental Ministry (MINAE) and Agriculture Ministry signed into law a decree to ban both the importation and used of the herbicide, Bromacil, after investigating its link to significant pollution, groundwater contamination, and negative health impacts on workers working in close proximity with the herbicide (Arias). Through environmental activism and government action, Costa Rica has begun to make progress towards sustainable development goals, life below water and life on land.

Bananas are Costa Rica's number one export, making up 11% of total exported goods ("What"). Since bananas are grown on such a large scale, it is imperative that banana plantations begin to implement shift towards more sustainable farming practices. Dole and Earth University are two banana producers in Costa Rica that have started to shift towards incorporating more environmentally friendly farming techniques. Dole and Earth University both utilize production units, recycled blue bags, and trenches for water in order to lower their environmental impact. A production unit is a root system with three generations of banana plants; the grandmother, mother, and daughter plant. After the first generation of a plant is harvested, it withers and remains a part of the root system rather than being cut away in order to provide nutrients to the next generation of banana plant. This process is repeated for the third generation, receiving nutrients from two previous generations of banana plants. Aside from supplying nutrients, implementation of production units prevents soil erosion, and previous generations keep weeds away from the root on the plant. Furthermore, blue bags made from recycled material, surround banana bunches. These bags create a microclimate to help bananas grow faster and protect banana bunches from insects, decreasing the need for pesticides, herbicides, and synthetic fertilizers. Finally, trenches run throughout both banana plantations, and they collect water in order to protect against wet and humid conditions that are breeding grounds for fungi and nematode worms. Nematode worms suck the nutrients out of the roots of plants and expose the roots to disease, so implementation of trenches reduces the amount of nematicides needed to be applied to banana plants.

While the plantations at Dole and Earth University share similarities in how they reduce their environmental impact, there a fundamental differences between the two concerning how to limit the application of fertilizers, herbicides, and nematicides. At Earth University, rather than

using herbicides to eliminate weeds, workers control weeds with a machete without eliminating them. In controlled quantities, weeds protect against soil erosion and absorb fungicides that are applied. Furthermore, the use of synthetic fertilizers is limited by combining conventional fertilizers with compost. Rather than haphazardly spraying fertilizers over the entire plantation, as is common on many large scale, conventional farms; workers apply fertilizers and nematicides directly to plants. Additionally, corridors of trees and forests split the banana plantation at Earth University into three units. The trees help control fungicides and reduce environmental impact associated with banana production. To protect against soil parasites, Earth University includes areas with a high diversity of plants scattered throughout the plantation. In contrast, Dole states that it is conscious of the pesticides used and that all fungicides are approved by the United States Department of Agriculture (USDA). However, Dole still uses an airplane to spray fungicides over the entire plantation.

Small-Scale Farming

While techniques implemented on small scale and organic farms are more sustainable, it is unrealistic to expect these techniques to be put in place for large, conventional production at this is point in time. Organic farming takes a lot of time and patience, and the yield on organic farms can be half of what it is on conventional farms, according to Victor at Café San Luis. Compost can take a long time to fully develop and bio-digesters fail to work in colder climates. Nevertheless, more rural areas with greater land availability, a sparser population, and limited access to large chain supermarkets have the potential to benefit immensely from the implementation of more small, organic farms. Having a small, organic farm allows families and smaller communities to support their families and utilize the land in a more sustainable manner.

For example, the Boruca are an indigenous population in Costa Rica. In this community, most families own 15 to 20 hectares of land with which to grow rice, beans, coffee, cocoa, fruits, corn, and tomatoes; the families usually eat food harvested rather than selling it ("Cultura"). Moreover, the San Luis Valley consists of a multitude of different organic farms; families grow sugarcane, corn, bananas, and other crops in order to provide nourishment for their families. In Costa Rica, the maintenance of small scale, organic farms help to fulfill goals in three of the areas related to sustainability that the United Nations has deemed critically important; people, planet, and prosperity ("Sustainable"). By families and communities producing their own food, it is evident to see how Costa Rica has begun to make strides towards fulfilling the sustainable development goal of zero hunger.

A smaller scale, organic farm can operate as a self-sustaining unit, operating in a continuous cycle from how the crops are grown to how waste products from the farm are used. By implementing sustainable agricultural techniques on smaller-scale farms, sustainability goals such as zero hunger, life under water, and life above land may be fulfilled. Compared to conventional, large-scale production, Café de Monteverde operates on a smaller scale, for it is an association of 12 families. Since opening Café de Monteverde in 1989, the 42 acres of land belonging to Café de Monteverde has been incorporated into secondary forest, which was reforested to compensate for its past history of deforestation for dairy farming ("About"). By encouraging and promoting small-scale farming, Costa Rica has become a model for repurposing land that was once decimated by dairy farming. From barren land, coffee plants, trees, and a plethora of other agricultural crops have sprung up due to the efforts of small-scale farmers. Farms such as Café de Monteverde, Café San Luis, and Finca la bella exemplify how Costa Rica

managed to increase forest cover from 21% in 1987 to 52.4% forest cover as of 2010 (Anders). These reforestation efforts contribute to the fulfillment of the sustainability goal, life on land.

Small-scale farms also promote sustainability by growing their crops in permaculture rather than in monoculture. Benefits of permaculture include decreased use of pesticides and herbicides, lower impact on the soil and watershed, maintenance of the soil's natural ecosystem, and genetic diversity of plant species. Growing crops in permaculture provides natural protection from soil erosion by wind and rain, and the variety in root depths of different plants upholds the integrity of the soil. Moreover, the increased range of crops provides a broader range of nutrients to be introduced into the soil, and the ecosystem of microorganism and bacteria in the soil thrives under these conditions ("6 Problems"). At La Tarde, a family cooperative of agricultural forest, seven different varieties of cacao trees are grown, for biodiversity promotes resistance to disease and a more stable agricultural system. While their primary focus is producing coffee, smaller scale farms like Café de Monteverde, Finca la Bella, and Café San Luis interweave other crops such as banana trees, plantain trees, citrus trees, mango trees, sugarcane, and beans. Trees like banana trees and citrus trees provide windbreaks as well as protect against soil erosion due to heavy rainfall, especially during the rainy season in Costa Rica. Furthermore, Café de Monteverde incorporates fragrant plants in the organic garden in order to attract bees and deter insects from damaging the crops. Not only does permaculture help fulfill the sustainability goal of "Life on Land," growing a variety of different crops provides farmers with a wider range of foods that they can either sell or use to feed their family. Either way, permaculture facilitates the achievement of the sustainability goals, Zero Poverty and No Hunger as well.

Moreover, fostering global partnerships and educational partnerships with small-scale farms will lead to continued growth of permaculture and implementation of bio-digesters. At

EARTH University in Costa Rica, students participate in the Institution's Community Development Program, in which they "work with small-scale, local producers on their farms and with organized groups to promote sustainable development" ("Community"). According to the Laureles family and Chepita at Finca la Virgen, they knew nothing about sustainable agricultural practices before students from the university began to advise them. Since then, Chepita has begun to compost and incorporate recycled material into her garden, and she plants with incense and colors in order to keep pests away rather than relying on pesticides and herbicides. Finally, the Laureles family has planted secondary forest on either side of the stream, for the forest acts as a buffer to clean water, preventing sediment from the farm from running into the stream. In doing so, it contributes to the fulfillment of the sustainable development goal of Life Below Water.

Furthermore, the bio digester on the Laureles property is one of over 1,030 bio-digesters that "have been installed in Costa Rica by EARTH or by individuals or institutions trained by EARTH. Bio-digesters help farmers convert manure and other organic waste into methane gas that can be used for cooking" ("Community"). Bio-digesters may be installed on a single-family farm, like the Laureles farm, or on a slightly broader scale, such as those seen at Café de Monteverde. However, bio-digesters may not be implemented on large-scale conventional farms where pesticides and herbicides are used or where the animals have been given antibiotics. At Café de Monteverde, one of the bio digesters ceased production of methane after a pig was given antibiotics because the feces disrupted the anaerobic fermentation processes carried out by the microorganisms with the bio-digesters. Nonetheless, bio-digesters provide an extremely efficient and sustainable source of gas that may be used to power appliances on smaller scale farms.

Farming on an individual level

In densely populated locations and urban environments, it is not realistic for a large quantity of families to possess enough land to maintain a successful small farm. In order to accommodate this, students conduct research on individual sustainable agricultural practices at Earth University in Costa Rica. EARTH provides a space for students to create experimental projects on how people can product their own food in an environmentally friendly and cost-efficient manner. Figure 1 pictures a model for an open greenhouse in a small, compact recycled container. The model contains enriched soil to aid plant growth without the use of conventional fertilizers. The components of the enriched soil include carbon, rice husks, and coconut fiber. The carbon acts as a natural filter, for it absorbs and releases water easily. The rice husks aerate the roots, and the coconut fiber can absorb nutrients and water, storing it for a longer period of time than carbon. Furthermore, students have researched an alternative to using soil when it is unavailable. Figure 2 shows plants in a bed of red volcanic rocks. The rocks provide volume and absorb nutrients and water. When plants root into these rocks, they can easily benefit from the nutrients and water stored in the rocks.

Figure 1

Figure 2

Figure 3

Figure 4

The research projects open the possibility for increased urban farming by creating inventive, space saving avenues for growing crops. In Figure 3, the white poles are used for support, and water courses through them. Plants with shallow roots, like onions and lettuce, can be grown in this system. The horizontal nature of this system allows for vertical stacking or storage underneath the white poles. Figure 4 features the same concept as the system in Figure 3 for

growing plants with shallows roots, but the plants are placed in a flatbed instead. However, the flatbed is cheaper to implement. In both systems, only a limited amount of soil is needed, and there is little weeding to be done. Additionally, students suggest the addition of two solutions of nutrients every morning: a macronutrient solution containing nitrogen and zinc and a micronutrient solution containing zinc, tin, and copper. The nutrient solution is mixed in the container featured in Figure 5, and it is fed either into the pipes or into the flatbed.

Figure 5

Students place a major emphasis on making use of recycled materials when experimenting with new methods for growing crops. In Figure 6, both the bags and the water bottled used to water the plants come from recycled materials. The hanging bags can be put either inside or outside, and there are usually small holes in bottom of the bags that prevent plants from being overwatered. In Figure 7, the same recycled bags are placed into a vertical farming system in order to be able to grow more crops in a smaller space. The bags need to be durable, and the white material reflects light, moderating the temperature of the soil. There are small holes in the bottom of the bag to prevent plants from being overwatered, but the water or nutrient solution is collected and recycled for future use.

Figure 6

Figure 7

The Present and Future of Sustainable Agriculture

With advances being made towards sustainable farming techniques on an individual basis, as well as on small and large-scale farms, Costa Rica provides a model for the successful

implementation of sustainable agricultural policies. However, Costa Rica is a relatively small nation, and it is about half the size of Kentucky ("San Jose"). In the future, it is necessary to reflect on whether Costa Rica can be used as a model for sustainable agriculture in much larger countries, like the United States. The United Nations projects that the world population will climb to 9.8 billion people by 2050 ("World"), with 68% of people living in urban areas ("68%"). If sustainable practices put in place in Costa Rica could be implemented on a larger scale, it could help mitigate food and environment issues related to population growth.

In the South Bronx, Stephen Ritz and his "Green Bronx Machine" initiative demonstrate the feasibility of implementing sustainable agricultural practices in an urban environment. Stephen Ritz teaches over-aged students in the special education program in South Bronx public schools, and he brought his lesson on how to grow fruits and vegetables out of the classroom (Gustafson 120). Students began planting fruits and vegetables in vacant lots, median strips, and decommissioned streets throughout the South Bronx ("Food"). Gradually, their efforts expanded to growing crops on the rooftops of buildings and on specially designed vertical garden walls with LED lights. At present, Ritz's students have grown over 25,000 pounds of vegetables (Gustafson 120). These crops are either fed to the local community of students, teachers, and senior citizens or sold at farmers markets by the students (Gustafson 120). The initiative of Stephen Ritz and his students proves that fresh fruits and vegetables can be grown and sold in a sustainable manner, even in the most seemingly impossible places.

Chinese philosopher Lao Tzu wrote, "The journey of a thousand miles must begin with a single step". Costa Rica did not become reforested overnight, and the entire conventional farming system cannot be turned upside down over night. However, consumers and individuals hold power in their choices. Instead of buying food from conventional grocery stores, one can

buy from local and regional farmers. Buying local or regional keeps food dollars within the local community and gives people the chance to see how their food is really grown (Gustafson 193). According to the Farmers Market Coalition, "Farmers who sell locally create 13 full time jobs per $1 million in revenue earned. Those that do not sell locally create only 3" ("Happy"). The journey towards a more sustainable agricultural system will be made with small steps and choices. One can plant a small garden in the backyard or even simply plant herbs in a pot on the window still. Every step matters, and hopefully, the sum total of individual choices will create a better world for future generations to live in.

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Works Cited

Anders, Wendy. “Costa Rica's Return to Forest in the Midst of Latin America's Deforestation.” *The Costa Rica Star*, The Costa Rica Star, 3 May 2017, news.co.cr/costa-ricas-return-forest-midst-latin-americas-deforestation/60212/.

Arias, L. “Environmentalists Demand Halt to Pineapple Expansion.” *The Tico Times Costa Rica*, The Tico Times, 15 May 2017, www.ticotimes.net/2017/05/15/pineapple-expansion-costa-rica.

Butler, Rhett A. “The Top 10 Most Biodiverse Countries.” *Mongabay: News and Inspiration From Nature's Frontline*, Mongabay, 25 Apr. 2017, news.mongabay.com/2016/05/top-10-biodiverse-countries/.

“Community Development Program.” EARTH, EARTH University, www.earth.ac.cr/en/about-earth/community-development-program/.

“Cultura.” *BORUCA*, www.boruca.org/es/cultura.

Environmental Services Payment (PSA) Program. Fondo Nacional De Financiamiento Forestal, 2014, www.fonafifo.go.cr/home/psa_eng/index.html

“Food For Others Garden.” *Green Bronx Machine*, greenbronxmachine.org/projects/food-for-others/.

Gustafson, Ellen. *We the Eaters: If We Change Dinner, We Can Change the World*. Rodale, 2014.

“Happy National Farmers Market Week!” *TSFM*, Farmers Market Coalition, 10 Aug. 2017, www.tsfarmersmarket.org/blog/2017/8/10/happy-national-farmers-market-week.

“Industrial Agriculture.” *Union of Concerned Scientists: Science for a Healthy Planet and Safer World*, Union of Concerned Scientists, www.ucsusa.org/our-work/food-agriculture/our-failing-food-system/industrial-agriculture#.WwAxndMvwWr.

Martin, Rod. “Conservation and Private Reserve Ownership in Costa Rica.” *Properties in Costa Rica*, 16 July 2013, www.propertiesincostarica.com/blog/conservation-and-private-reserve-ownership-in-costa-rica/.

Ravishankara, A. R., et al. “Nitrous Oxide (N2O): The Dominant Ozone-Depleting Substance

Emitted in the 21st Century." *Science*, vol. 326, no. 5949, 2009, pp. 123–125., doi:10.1126/science.1176985.

Ritchie, Hannah, and Max Roser. "CO_2 and Other Greenhouse Gas Emissions." *Our World in Data*, 2018, ourworldindata.org/co2-and-other-greenhouse-gas-emissions.

"San Jose, Costa Rica." *Modern Language Studies Abroad*, www.mlsa.com/costa-rica-1.html.

"Sustainable Development Goals." *Sustainable Development Knowledge Platform*, United Nations, 2015, sustainabledevelopment.un.org/topics/sustainabledevelopmentgoals.

"What Does Costa Rica Export? (2016)." *OEC - Sweden (SWE) Exports, Imports, and Trade Partners*, Observatory of Economic Complexity, 2016, atlas.media.mit.edu/en/visualize/tree_map/hs92/export/cri/all/show/2016/.

"World Population Projected to Reach 9.8 Billion in 2050, and 11.2 Billion in 2100." *United Nations Department of Economic and Social Affairs*, United Nations, 21 June 2017, www.un.org/development/desa/en/news/population/world-population-prospects-2017.html.

Yale Center for Environmental Law & Policy, and Center for International Earth Science Information Network. "2018 Environmental Performance Index." *Environmental Performance Index*, 2018, epi.envirocenter.yale.edu/.

"6 Problems with Monoculture Farming." *REGENERATIVE.com: Sustainable Living and Personal Growth*, Regenerative Corporation, 2017, www.regenerative.com/magazine/six-problems-monoculture-farming.

"68% of the World Population Projected to Live in Urban Areas by 2050, Says UN." *United Nations Department of Economic and Social Affairs*, United Nations, 16 May 2018, www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html.